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10/801,650	03/17/2004	Satoshi Shimada	042199	1693

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EXAMINER	
HOANG, ANN THI	
ART UNIT	**PAPER NUMBER**
2836	

DATE MAILED: 01/17/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

H·A

Office Action Summary	Application No.	Applicant(s)	
	10/801,650	SHIMADA ET AL.	
	Examiner	**Art Unit**	
	Ann T. Hoang	2836	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 3/17/04.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-27 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-4,6-11 and 13-27 is/are rejected.

7)☒ Claim(s) 5, 12 is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 17 March 2004 is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date 3/17/04.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Drawings

1. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: 66. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Claim Objections

2. Claims 1 and 8 are misdescriptive in claiming that the current circulating diode is connected in parallel to the solenoid. The figures show the current circulating diode to be connected in parallel to a series circuit composed of the solenoid and other components across which a voltage drop may occur. Appropriate correction is required.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. Claims 1-4, 7-11 and 14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Melbert et al. (US 6,744,615) in view of Fujiwara et al. (US 5,978,201).

Regarding claim 1, Melbert et al. teaches a device for driving a solenoid (113), comprising:

a power supply (U_V);

a switching element (T1) connected between said power supply (U_V) and said solenoid (113) in series therewith;

a current circulating diode (D2) connected in parallel to a series circuit composed of said solenoid (113), a switching element (T2), and a resistor (R), so that the cathode of said current circulating diode (D2) is connected between said switching element (T1) and said solenoid (113);

a current detecting circuit (4a) for detecting an actual current flowing through said solenoid (113); and

PID computing means (3a) for computing a control signal (KS) according to a difference between a target current and said actual current detected by said current detecting circuit (4a), and outputting said control signal (KS).

PID computing means (3a) includes comparators (33, 36), which receive signals that are a function of the solenoid current measured by current meter (4a). The measured current values are compared to target current values (SW1, SW2) and the comparison results are input as control signal values (KS, KS 2) to a collective driving means (34, 35), which controls the on/off switching of switching element (T1). See Fig. 4; column 3, lines 14-25; and column 6, lines 15-17. The reference does not explicitly disclose that control signals (KS, KS 2) are on-duty and off-duty values, but it is understood that (KS, KS 2) represent on-duty and off-duty values, since (KS) is an asserted signal when the detected current reading input to a comparator (33) is higher than a threshold value (SW1).

Melbert et al. also discloses a driving means (35, 342, 343, 344) for generating a driver signal according to inputting of said on-duty value and supplying said driver signal to said switching element (T1) to on/off control said switching element (T1). See Fig. 5. The reference does not disclose the driving means to be a PWM duty driving means.

However, Fujiwara et al. discloses supplying a PWM duty signal (PWM) to a switching element (2) to on/off control said switching element (2) corresponding to a target value of current through a solenoid (1). See Fig. 10 and column 1, lines 35-40. It would have been obvious to one of ordinary skill in the art at the time of the invention to use the driving means of Melbert et al. to supply a PWM duty signal to the switching element, as disclosed by Fujiwara et al., in order to provide a means to accurately establish a duty ratio which matches the target value of current through the solenoid.

Melbert et al. also discloses a state of the device for driving solenoid (113) in which both of two switching elements (T1, T2) are off, causing both of two current circulating diodes (D2, D1) to conduct and the current in solenoid (113) to decrease very rapidly. See Fig. 4 and column 3, lines 54-58. The reference does not expressly disclose that this results in a reverse voltage of power supply (U_V) being applied to solenoid (1).

However, Fujiwara et al. discloses turning off all switching elements (5, 2, 9) of a device for driving a solenoid (1) in order for a diode (3) to apply a voltage of a power supply (V) as a reverse voltage to solenoid (1) according to a duty signal (PWM) in order to facilitate rapid attenuation of the current across solenoid (1). See Fig. 11 and column 2, lines 10-18. It would have been obvious to one of ordinary skill in the art at the time of the invention that the additional switching element and diode of Melbert et al. would be used to as reverse voltage applying means capable of applying a voltage of said power supply as a reverse voltage to said solenoid according to inputting of said off-duty value when said switching element (T1) is off, in order to facilitate rapid attenuation of the current across the solenoid, thus reducing the response time of the device for driving the solenoid.

Regarding claim 2, said reverse voltage applying means (T2, D1) of Melbert et al. comprises:

a second switching element (T2) connected between the negative electrode of said power supply (U_V) and said solenoid (113) in series therewith;

a second current circulating diode (D1) connected in parallel to a series circuit composed of said switching element (T1) and said solenoid (113) so that the cathode of said second current circulating diode (D1) is connected between said power supply (U_V) and said switching element (T1); and

second driving means (35, 341, 345, 346) for generating a second driving signal according to inputting of said off-duty value and supplying said second driving signal to said second switching element (T2) to on/off control said second switching element (T2).

A collective driving means (34, 35) generates signals according to inputting of both on-duty and off-duty values. The driver circuit (34) of collective driving means (34, 35) uses D flip-flops (341, 342) and logic gates (343, 344, 345, 346) to drive switching elements (T1, T2). More specifically, D flip-flop (342) and logic gates (343, 344) are dedicated to switching element (T1) and D flip-flop (341) and logic gates (345, 346) are dedicated to second switching element (T2). See Figs. 4 and 5.

Regarding claim 3, the above-mentioned reverse voltage applying means (T2, D1) would comprise an off-duty value selecting means for selecting said off-duty value output from said PID computing means (3a). Melbert et al. discloses an adder for adding a preset value at the pertinent inputs of comparators (33, 36). See column 4, lines 60-63.

Regarding claim 4, Melbert et al. discloses that said second driving means (35, 341, 345, 346) comprises a timer (35) and a driver circuit (341, 345, 346). The outputs of driver circuit (341, 345, 346) are generated as a function of a timing signal output by

timer (35), which is an oscillator. The reference discloses that an additional driver may be located between logic gate (346) and switching element (T2). See Fig. 4; column 3, lines 26-29; and column 4, lines 46-49.

Regarding claim 7, Melbert et al. shows only one power supply terminal (U_V) and a ground terminal. Thus, it is understood that said power supply comprises a single power supply and not a split power supply.

Regarding claim 8, claim 8 cites all the limitations of claim 1 with the addition that the device is for driving an electromagnetic actuator of a particular type. Melbert et al. teaches the device of claim 1, rejected above, to be for driving an electromagnetic actuator (12) including a ringlike core member (112) having an annular groove, an annular solenoid (113) accommodated in said annular groove of said core member, and a ringlike armature member (116) opposed to said core member with a given gap (l) defined therebetween. See Fig. 1; column 1, line 45; and column 2, lines 53-67.

Regarding claim 9, claim 9 corresponds to claim 2 and is rejected under the same reasoning as that of claim 2. See above rejection.

Regarding claim 10, claim 10 corresponds to claim 3 and is rejected under the same reasoning as that of claim 3. See above rejection.

Regarding claim 11, claim 11 corresponds to claim 4 and is rejected under the same reasoning as that of claim 4. See above rejection.

Regarding claim 14, claim 14 corresponds to claim 7 and is rejected under the same reasoning as that of claim 7. See above rejection.

5. Claims 6 and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Melbert et al. (US 6,744,615) in view of Fujiwara et al. (US 5,978,201) as applied to claim 1 above, and further in view of Przybylski (US 6,424,873).

Regarding claim 6, Melbert et al. discloses that computing means (3a) may be designed as a PID computing means, but does not disclose the internal operation of the PID computing means (3a).

However, Przybylski discloses PID computing means in the prior art as having integral term calculating means for calculating an integral term according to a detected error, in other words according to the target current and actual current of a device. See column 2, lines 12-13. The reference also discloses an operation performed in the prior art wherein the integral term is reset to 0 when a detected current signal does not exceed the PID computing mean's output limit, in other words when it becomes a predetermined value or less. See column 3, lines 39-44. It would have been obvious to one of ordinary skill in the art at the time of the invention to use the PID computing means of Przybylski in the device for driving a solenoid of Melbert et al. in order to provide a means of incrementing the output of the PID computing means in the event of detected continual error, but at the same time preventing it from exceeding the acceptable output limit of the PID computing means.

Regarding claim13, claim 13 corresponds to claim 6 and is rejected under the same reasoning as that of claim 6. See above rejection.

6. Claims 15, 18, 21-23, and 26-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Melbert et al. (US 6,744,615) in view of Swinbanks (US 6,462,927) and Seale et al. (US 2001/0043450).

Regarding claim 15, Melbert et al. discloses a control device for an electromagnetic actuator (12) including a core member (112) having a groove, a solenoid (113) accommodated in said groove of said core member (112), and an armature member (116) opposed to said core member (112) with a gap (l) defined therebetween, said control device comprising:

gap detecting means for detecting said gap between said core member (112) and said armature member (116);

current detecting means (4a) for detecting an actual current flowing through said solenoid (113);

a feedback controller (3a) for feedback controlling said actual current so that said actual current becomes equal to a target current; and

solenoid drive signal generating means (34, 35) for generating a solenoid drive signal according to outputs from said feedback controller (3a).

The reference discloses a means of calculating gap (l) with equations involving related variables so that a position sensor is not needed. A feedback line is shown in Fig. 4 from the source terminal of second switching element (T2), through current detecting means (4a), through differentiator (31) and divider (32), and into comparators (33, 36), which will output control signals (KS, KS 2) into driver circuit (34). See Fig. 4, equations (G2, G2) and column 2, lines 6-10. The reference does not disclose a

feedforward controller for feedforward controlling. Neither does the reference disclose changing an integral term constant according to said gap detected by gap detecting means.

However, Swinbanks discloses a feedforward controller (13) for feedforward controlling a target current in an support actuator (10) in order to produce a gap (16) between an electromagnet (11) and a support armature (15). See abstract and Fig. 3. It would have been obvious to one of ordinary skill in the art at the time of the invention to incorporate the feedforward control of Swinbanks into the solenoid drive signal generating means of Melbert et al. in order to respond to system behavior and measurements in a pre-defined manner and thereby provide a more effective means of maintaining the desired state of the system.

Moreover, Seale et al. discloses a feedback controller for an electromagnetic actuator that changes an integral term constant according to a solenoid gap (X) detected by a gap detecting means. See page 7, paragraph 29. It would have been obvious to one of ordinary skill in the art at the time of the invention to make the detected gap of Melbert et al. a variable on which to base the change of the integral term constant, as disclosed by Seale et al., in order to effectively adjust the current control of the electromagnetic actuator in response to measured gap length and maintain desired system behavior using gap measurements. Additionally, Seale et al. mentions on page 4, paragraph 15 that the solenoid gap is identified as the parameter to be sensed and controlled the feedback controller for an electromagnetic actuator.

Regarding claim 18, Swinbanks discloses that feedforward controller (13) changes a transfer function and gain according to said gap (16) detected by a gap detecting means (17). See abstract; Fig. 3; column 2, lines 65-67; column 3, line 1; column 4, lines 7-41; and column 6, lines 61-65.

Regarding claim 21, Seale et al. discloses the gap detecting means to comprise a magnetic flux sensor for detecting a magnetic flux intensity (Φ) generated from the solenoid. See page 6, paragraph 26 and page 7, paragraph 29.

Regarding claim 22, Melbert et al. discloses a target filter (31, 32), provided at the front stage of the feedback controller (3a), that differentiates the current (I) through solenoid (113) and divides the time differential (dI/dt) of current (I) and current (I). The relationship between the target time differential (dI/dt), which is representative of the target current, and the measured current (I) are input to comparators (33, 36) to be compared to threshold values (SW1, SW2). See Fig. 4; column 2, lines 22-27; column 3, lines 18-25; and column 4, lines 27-30. Seale et al. also discloses the calculation of an error parameter by subtracting a current target parameter from a current sense parameter at some stage in the feedback control. See page 4, paragraph 14 and page 20, paragraph 191.

Regarding claim 23, claim 23 is rejected under the same reasoning as that of claim 18.

Regarding claim 26, claim 26 is rejected under the same reasoning as that of claim 21.

Regarding claim 27, claim 27 is rejected under the same reasoning as that of claim 22. Therefore, please see the above rejections on claims 18, 21 and 22, respectively.

7. Claims 16-17, 19-20, 24 and 25 are rejected under 35 U.S.C. 103(a) as being unpatentable over Melbert et al. (US 6,744,615) in view of Swinbanks (US 6,462,927) and Seale et al. (US 2001/0043450), as applied to claim 15, and further in view of Lukich et al. (US 6,133,643).

Regarding claim 16, Seale et al. does not disclose a plurality of predetermined integral term constants. However, Lukich et al. discloses control system using a feedback control algorithm to select an appropriate gain value from a look-up table in response to system characteristics. The look-up table stores a plurality of predetermined values, one of which will be selected as most appropriate according to measurements in the engine. See abstract and Fig. 3. It would have been obvious to one of ordinary skill in the art at the time of the invention to store predetermined integral term constants in a look-up table similar to that of Lukich et al. for selection based on the detected gap in order to reduce computing time and expenses. Doing so would replace runtime computation with a faster, cheaper means of determining an appropriate integral term constant.

Regarding claim 17, Seale et al. discloses that when the gap (X) is detected as to be too large relative to the target, the feedback controller must demand more current in order to drive gap (X) back to a smaller value so that less current is demanded. A demand for more current requires a larger integral term constants in traditional PID

control algorithms such as that of Seale et al., so it is understood that the feedback controller of Seale et al. selects a larger integral term constant when said gap is large, and selects a smaller integral term constant when said gap becomes smaller and there is a lesser demand for current. See page 7, paragraph 29.

Regarding claim 19, Swinbanks does not disclose a plurality of predetermined transfer functions or gains. However, Lukich et al. discloses control system using a feedback control algorithm to select an appropriate gain value from a look-up table in response to system characteristics. The look-up table stores a plurality of predetermined values, one of which will be selected as most appropriate according to measurements in the engine. See abstract and Fig. 3. It would have been obvious to one of ordinary skill in the art at the time of the invention to store predetermined transfer functions and/or gains in a look-up table similar to that of Lukich et al. for selection based on the detected gap in order to reduce computing time and expenses. Doing so would replace runtime computation with a faster, cheaper means of determining an appropriate integral term constant.

Regarding claim 20, Swinbanks describes the attraction force exerted by electromagnet (11) on support armature (15) as being analogous to a strong negative spring and that it is common practice to employ high gain feedback as a counterforce against the strong negative spring. The attraction force is indirectly correlated to the magnitude of gap (16) between electromagnet (11) and support armature (15) and directly correlated with the need for a high gain. Therefore, feedforward controller (13)

of Swinbanks selects a smaller gain when said gap (16) is large, and selects a larger gain when said gap (16) becomes smaller. See column 1, lines 23-40.

Regarding claim 24, claim 24 is rejected under the same reasoning as that of claim 19.

Regarding claim 25, claim 25 is rejected under the same reasoning as that of claim 20. Therefore, please see the above rejections on claims 19 and 20, respectively.

Allowable Subject Matter

8. Claims 5 and 12 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. The following is a statement of reasons for the indication of allowable subject matter: The prior art does not teach a device for driving a solenoid or magnetic actuator that is as described above and that also comprises a means for calculating the absolute values of on-duty values and off-duty values, an inverter that inverts the signs of the on-duty values and off-duty values, and a NAND gate whose inputs are coupled to the output of the absolute value calculating means and the inverter output.

Conclusion

9. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Mikami et al. (US 5,790,364) discloses a PWM control system

for a linear solenoid valve employing feedback and feedforward control techniques.

Pattantyus (US 6,404,612) discloses a system for driving a solenoid using PWM.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ann T. Hoang, whose telephone number is 571-272-2724. The examiner can normally be reached Mondays through Fridays, 8:00 a.m. to 5:00 p.m.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Brian Sircus, can be reached at 571-272-2058. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

ATH
1/9/06

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PRIMARY EXAMINER